invention includes a conductive reflector which is electrically and mechanically attached to the interior cavity, opposite the aperture, and positioned relative to the electron beam to reflect electrons and secondary electrons into the dissipation cavity. Applicant submits that the indefinite nature of these claims referred to by the Examiner has been corrected. Support for the amendment can be found at paragraph 00016 of the specification.

Referring to the rejection of claim 1-6, 8-10, 12-13, 15 and 17 under 35 USC §102(b) over Symons (US 6,380,803), it is urged in the Office Action that Symons discloses a multiple depressed collector (30) comprising:

an electrically conductive dissipation cavity (29);

a front wall located at one side of the dissipation cavity (29) having an aperture (16) to allow the passage of the electron beam into the cavity (29);

a rear wall in the dissipation cavity (29), opposite the front wall, positioned and shaped such that electrons which strike it, and secondary electrons, are captured in the dissipation cavity (29); and a voltage source (VB or AC source (40) electrically connected to the collector (30).

Applicant submits, however, that the Symons cavity (29) is not a dissipation cavity but is the circuit cavity where electron beam power is converted to radio frequency power. Symons col.5, lines 9-11 describe "...the cavity (29) for extracting RF electromagnetic energy ...." Symons makes it clear that the device collector is item (30). The aperture (16) disclosed in Symons allows the passage of the electron beam into cavity 29 where an inductive loop (25) is disposed within the cavity (29) for extracting RF electromagnetic energy from the cavity. Col. 5, lines 1-11. In Symons, after passing through drift tube section (24), the electron beam passes into the multistage depressed collector section (30). The magnetic field disclosed in Symons is

used to confine the beam to a constant diameter in the inductive output tube (10). Symons does not disclose the presence of a magnetic field once the beam enters the multistage depressed collector. At that point, the beam is allowed to disperse under space charge forces where they are sorted by energy and captured by multiple collectors. In the applicant's device, the size constraints are such that the magnetic field in the submillimeter and terahertz devices cannot be terminated between the RF circuit and the collector. Therefore, the electron beam remains confined by the magnetic field in the collector region which is different from the devices described by Symons where the electrons are allowed to disperse by space charge forces.

Claims 1-6, 8-10, 12-13, 15 and 17 recites the reflection of both primary electrons and secondary electrons into the dissipation cavity where they are trapped or captured greatly increasing the efficiency of the device. Symons does not describe a technique for trapping or capturing secondary electrons in his collector (30).

In the Office Action, Claims 2, 4, and 5 are rejected over Symons. The Office Action states that Symons also discloses a depressed collector comprising means for depressing the voltage of the collector (30) and means for trapping the electrons after they exit the electron beam device. The Applicant submits that Symons does not include or describe a "means for trapping electrons after they exit the electron beam device." After the electrons in the Symons device enter the collector region, they disperse according to energy level and are collected by electrodynamic effects on one of a series of collector assemblies. Symons does not describe a means for trapping electrons. As the Applicant's invention discloses, simple depression of the existing collector geometry results in excessive generation of backscattered electrons and true secondary electrons. The secondary electron yield approaches one, meaning that almost as many

secondary electrons are generated as there are incoming primary electrons. Secondary electrons are accelerated at full voltage and impact the main body of the device severely limiting the amount of energy that can be recovered from the electron beam. See Applicant's specification at paragraph 0007. No means is described in the Symons device for capturing backscatter or secondary electrons.

Referring to the rejection of claim 3, under 35 USC §102(b) as being unpatentable over Symons (US 6,380,803); the Office Action states that Symons discloses a depressed collector (30) for use with the device emitting an electron beam containing electrons traversing into the collector where energy is recovered from the electron beam, the collector (30) comprising:

means for decelerating said electrons after they exit the electron beam device; and

means for trapping said electrons after they exit said electron beam device.

Applicant submits that although Symons discloses a method of collecting electrons after they enter the collector region where they are dispersed based on energy, and a method of excluding RF electric fields from the region between the collector elements so that electrons which give up energy will not be reaccelerated or further slowed in the collector, Symons does not describe a method of decelerating electrons. Nor, for the reasons discussed above, does Symons describe a means for trapping electrons after they exit the electron beam device. In Symons, the electrons are collected through electric field effects but no means is described in Symons of trapping electrons, backscattered electrons and secondary electrons as is disclosed in Applicant's invention.

In the Office Action, the Examiner rejects Claims 8 and 15 under 35 USC §102(b) over Symons (US 6,380,803). The Office Action states that Symons discloses a rear wall shaped such

that the reflected electrons and secondary electrons are captured in the dissipation cavity. Examiner references figures 5-7, column 11, lines 29-67 and column 12, lines 1-3. Applicant can find no discussion or disclosure of shaping of a rear wall in the cited figures or references in Symons. Symons at column 8, lines 20-23 describes a final collector stage in Fig. 4, shaped as a spike to form a radial electric field region to force incoming electrons radially outward but the Symons technique relies on electric field effects to force the electrons away from the final collector toward other collector stages where they are collected. Claims 8 and 15 in the Applicant's device does not recite the use of electric field effects to force electrons away from the rear wall. Instead, claims 8 and 15 recite that incoming electrons are reflected into the dissipation cavity where they are captured. There is no discussion or disclosure in Symons recognizing the importance of reflected electrons and secondary electrons or a description of how they are or could be collected or captured in the Symons invention as is recited in claims 8 and 15.

For the foregoing reasons, it is submitted that claims 1-6, 8-10, 12-13, 15 and 17 are patentably distinguishable over the Symons reference.

Referring to the rejection of Claims 7-14 and 18-19 under 35 USC §103(a) as being unpatentable over Symons (US 6,380,803). It is urged in the Office Action that it would have been an obvious matter of design choice to have planar or sheet electron or the large aspect ratio annular electron beam. The Examiner states that since the applicant has not disclosed that the planar or sheet electron or the large aspect ratio annular beam solves any stated problem or is for any particular purpose and it appears the invention would perform equally well with the planar or sheet electron or the large aspect ratio annular beam.

Applicant submits, however, sheet-type electron beams are currently utilized in submillimeter frequency backward wave oscillators. Current submillimeter frequency backward wave oscillators typically operate with efficiencies with less than five percent. See Applicant's specification at paragraph 0006. Depressed collectors have been routinely incorporated into cylindrically symmetric vacuum tubes such as travelling wave tubes and klystrons for more than 40 years. Such devices are produced by many companies (paragraph 0004). Unfortunately, many devices including submillimeter frequency backward wave oscillators are not amenable to techniques utilized to implement depressed collectors in prior art such as cylindrically symmetric vacuum tubes, travelling wave tubes and klystrons. Simple depression of existing collector geometry results in excessive generation of backscattered electrons and true secondary electrons. At the voltages used in the submillimeter frequency backward wave oscillator device, the secondary electron yield can approach one, meaning that almost as many secondary electrons are generated as are incoming primary electrons. The secondary electrons are accelerated at full voltage and impact the main body of the device severely limiting the amount of energy that can be recovered from the electron beam (paragraph 0007). An additional complication is the rectangular geometry of a device using a rectangular sheet electron beam. The rectangular geometry is not amenable to the cylindrical geometrical configurations utilized in the prior art (paragraph 0008). Finally, the backward wave oscillator device operates at small currents where space charged forces are small and the techniques used to control beam spread are limited by the presence of a strong uniform magnetic field. Because the distance between the body of the device and the collector is often less than 100 microns, variations of magnetic field on this scale

would be difficult to implement without adversely affecting beam transmission through the circuit (paragraph 0009).

In cylindrical collection devices as described in Symons, the electron beam is typically guided through the RF circuit by an axial magnetic field. Symons describes this technique at column 8, lines 3-10. An iron pole piece terminates the field so there is no magnetic field in the collector. The electrons then diverge from the axis as a result of space charged forces. Symons shows these diverging electrons as 82-86 in Fig. 4. The slower electrons diverge radially at a faster rate than the more energetic electrons thus providing a mechanism for sorting electrons by energy and optimizing collector efficiency. Note than in the Symons invention there is no mechanism for controlling the impact angle of the electrons on the collector surfaces. Nor is there any attempt to contain secondary electrons that may be emitted from these surfaces. It is known that secondary electron emission yield and their energy distribution is a function of primary electron impact angle.

In sheet beam and large aspect ratio annular electron beam devices, space-charged forces can be dramatically reduced by dispersing the beam laterally. This characteristic can allow significant reduction in the electron beam voltage, thereby improving circuit efficiency, increasing bandwidth and reducing radiation problems. It also allows development of a new class of devices using planar circuits produced lithographically at significantly higher frequencies.

There are two distinct differences between these devices and the ones described by Symons. First the magnetic field must be significantly stronger for sheet beam devices than for cylindrical beam devices in order to minimize beam distortion at the outer edges of the electron

beam where electrical forces are unbalanced. Self magnetic forces cannot be used to help beam confinement. Second, for submillimeter and terahertz sources, the size constraints are such that the magnetic field cannot be terminated between the RF circuit and the collector. Therefore, the electron beam remains confined by the magnetic field in the collector region which is different from the devices as described by Symons where the magnetic field is terminated as the beam enters the collector region and the beam is allowed to disperse through space-charged forces.

For these reasons, in the Applicant's invention the electron beam remains undispersed in sheet beam and annular devices as it enters the collector region. After passing through the aperture in the front wall of the collector, the beam traverses the cavity and strikes the back wall. The back wall is shaped or angled in such a manner that primary electrons in the beam strike the wall at a controlled angle. Primary electrons and secondary electrons are direct-reflected away from the collector aperture and into the body of the collector to prevent their return to the RF circuit area of the device. It is not possible to utilized space-charged forces to disperse electron beam as in the Symons device and the primary purpose of the cavity is to trap reflected and primary electrons. Symons does not address reflected or secondary electrons in his invention. It would not be possible to simply use the Symons cylindrical beam technology on sheet beam, planar and annular ring devices and how to do so would not have been obvious to Symons.

For the foregoing reasons, it is submitted that it would not have been an obvious matter of design choice to have planar or sheet electrons or the large aspect ratio electron beams applied to the Symons device and claims 7-14 and 18-19 are patentable over Symons.

The remaining prior art of record — Symons (US 5,650,751); Rawls, Jr. (US 3,824,425), Doyle (US 3,717,787), Brown (US 6,208,079) and Giebeler (US 3,780,336) — have been

reviewed. Symons (US 5,650,751) is the parent of Symons (US 6,380,803). Symons (US 5,650,751) is not pertinent for all of the reasons discussed above with respect to Symons (US 6,380,803).

Rawls, Jr. (US 3,824,425) reveals an invention for a more rugged suppressor electrode for operation with a depressed potential electron beam collector. It does not describe an invention for trapping electrons. It is not adaptable to a sheet beam or annular beam device because it is inherently cylindrical and conic in shape.

Doyle (US 3,717,787) is an invention for a rugged, thermal-shock-proof electron beam collector. It utilizes the collector described in Rawls, Jr. (US 3,824,425) discussed above, column 2, lines 41-47. It does not describe an invention for trapping electrons and is not adaptable to sheet beam or annular beam devices because it is inherently cylindrical and conic in shape.

Brown, II (US 6,208,079) depends on radial dispersion of the electron beams by space-charged forces to collect the electrons, column 2, lines 52-65. As discussed above the Applicant's invention does not use space-charged effects to disperse the beam but instead, captures the electrons and secondary electrons in a trap.

Giebeler (US 3,780,336) electric field effects are used to control the beam expansions so that the electrons can be collected, column 4, lines 31-62. The Applicant's invention does not rely on electric field effects to collect electrons. Instead, electrons and secondary electrons are captured in a trap.

In view of the foregoing remarks, it is urged this case is now in condition for allowance and a notice to that effect is requested.

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1. (once amended) An electron beam collector comprising:

an electrically conductive dissipation cavity;

a front wall located at one side of said dissipation cavity having an aperture to allow the passage of the electron beam into the cavity;

a conductive reflector electrically and mechanically attached to said interior cavity in said enclosure, opposite said aperture, positioned relative to said electron beam to reflect electrons and secondary electrons, into said dissipation cavity; and

[a rear wall in said dissipation cavity, opposite the front wall, positioned and shaped such that electrons which strike it, and secondary electrons, are captured in said dissipation cavity; and]

a voltage source electrically connected to said collector.

1. (once amended) An electron beam collector comprising:

an electrically conductive dissipation cavity;

a front wall located at one side of said dissipation cavity having an aperture to allow the passage of the electron beam into the cavity;

a conductive reflector electrically and mechanically attached to said interior cavity in said enclosure, opposite said aperture, positioned relative to said electron beam to reflect electrons and secondary electrons, into said dissipation cavity; and

a voltage source electrically connected to said collector.

6. (once amended) A depressed voltage collector for use with a device emitting an electron beam containing electrons traversing into the collector where energy is recovered from the electron beam, said collector comprising:

an electrically conductive dissipation cavity;

a front wall located at one side of said dissipation cavity having an aperture to allow the passage of said electron beam into said cavity;

<u>a conductive reflector electrically and mechanically attached to said interior cavity in said enclosure, opposite said aperture, positioned relative to said electron beam to reflect electrons and secondary electrons, into said dissipation cavity; and</u>

[a rear wall in said dissipation cavity, opposite the front wall, positioned and shaped such that electrons which strike it, and secondary electrons, are captured in said dissipation cavity; and]

a voltage source electrically connected to the collector and to the device.

6. (once amended) A depressed voltage collector for use with a device emitting an electron beam containing electrons traversing into the collector where energy is recovered from the electron beam, said collector comprising:

an electrically conductive dissipation cavity;

a front wall located at one side of said dissipation cavity having an aperture to allow the passage of said electron beam into said cavity;

a conductive reflector electrically and mechanically attached to said interior cavity in said enclosure, opposite said aperture, positioned relative to said electron beam to reflect electrons and secondary electrons, into said dissipation cavity; and

a voltage source electrically connected to the collector and to the device.

9. (once amended) A depressed voltage collector for use with a device emitting a rectangular sheet electron beam of electrons traversing into the collector where energy is recovered from the electron beam, said collector comprising:

an electrically conductive dissipation cavity;

a front wall located at one side of said dissipation cavity having an aperture to allow the passage of said rectangular sheet electron beam into said cavity;

a conductive reflector electrically and mechanically attached to said interior cavity in said enclosure, opposite said aperture, positioned relative to said rectangular sheet electron beam to reflect electrons and secondary electrons, into said dissipation cavity; and

[a rear wall in said dissipation cavity, opposite the front wall, positioned and shaped such that electrons which strike it, and secondary electrons, are captured in said dissipation cavity; and]

a voltage source electrically connected to said collector and to said device.

9. (once amended) A depressed voltage collector for use with a device emitting a rectangular sheet electron beam of electrons traversing into the collector where energy is recovered from the electron beam, said collector comprising:

an electrically conductive dissipation cavity;

a front wall located at one side of said dissipation cavity having an aperture to allow the passage of said rectangular sheet electron beam into said cavity;

a conductive reflector electrically and mechanically attached to said interior cavity in said enclosure, opposite said aperture, positioned relative to said rectangular sheet electron beam to reflect electrons and secondary electrons, into said dissipation cavity; and

a voltage source electrically connected to said collector and to said device.

10. (once amended) A depressed voltage collector for use with a device emitting a large aspect ratio annular electron beam of electrons traversing into the collector where energy is recovered from the electron beam, said collector comprising:

an electrically conductive dissipation cavity;

a front wall located at one side of said dissipation cavity having an annular aperture to allow the passage of said annular electron beam into said cavity;

<u>a conductive reflector electrically and mechanically attached to said interior cavity in said enclosure, opposite said aperture, positioned relative to said annular electron beam to reflect electrons and secondary electrons, into said dissipation cavity; and</u>

[a rear wall in said dissipation cavity, opposite the front wall, positioned and shaped such that electrons which strike it, and secondary electrons, are captured in said dissipation cavity; and]

a voltage source electrically connected to said collector and to said device

10. (once amended) A depressed voltage collector for use with a device emitting a large aspect ratio annular electron beam of electrons traversing into the collector where energy is recovered from the electron beam, said collector comprising:

an electrically conductive dissipation cavity;

a front wall located at one side of said dissipation cavity having an annular aperture to allow the passage of said annular electron beam into said cavity;

a conductive reflector electrically and mechanically attached to said interior cavity in said enclosure, opposite said aperture, positioned relative to said annular electron beam to reflect electrons and secondary electrons, into said dissipation cavity; and

a voltage source electrically connected to said collector and to said device

13. (once amended) A single stage depressed voltage collector for use with a device emitting an electron beam containing electrons traversing into the collector where energy is recovered from the electron beam, said collector comprising:

an electrically conductive dissipation cavity;

a front wall located at one side of said dissipation cavity having an aperture to allow the passage of said electron beam into said cavity;

<u>a conductive reflector electrically and mechanically attached to said interior cavity in said enclosure, opposite said aperture, positioned relative to said electron beam to reflect electrons and secondary electrons, into said dissipation cavity; and</u>

[a rear wall in said dissipation cavity, opposite the front wall, positioned and shaped such that electrons which strike it, and secondary electrons, are captured in said dissipation cavity; and]

a voltage source electrically connected to the collector and to the device.

13. (once amended) A single stage depressed voltage collector for use with a device emitting an electron beam containing electrons traversing into the collector where energy is recovered from the electron beam, said collector comprising:

an electrically conductive dissipation cavity;

a front wall located at one side of said dissipation cavity having an aperture to allow the passage of said electron beam into said cavity;

a conductive reflector electrically and mechanically attached to said interior cavity in said enclosure, opposite said aperture, positioned relative to said electron beam to reflect electrons and secondary electrons, into said dissipation cavity; and

a voltage source electrically connected to the collector and to the device.